



# Videotex '84



## THE BROADBAND SOLUTION-METROPOLITAN CATV NETWORKS

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Current network approaches to videotex, namely the public switched telephone network and LADT, either lack the data traffic handling capacity to support a sizable videotex business or are too costly to enjoy widespread penetration in the residential market. This paper describes a broadband CATV networking approach that not only overcomes these obstacles but offers a high speed (128 kbps) capacity which will support the deployment of totally software based (downloaded) terminals.



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## INTRODUCTION

One of the central questions facing the videotex industry, if in fact it is to become a significant industry in the foreseeable future, is the problem of economically supporting communications between a large base of residential subscribers within a metropolitan area and the handful of major service providers serving that area. The process of collecting, concentrating, and switching this traffic, (a problem long ago solved for voice telephony), has never really been accomplished for interactive data communications within a metropolitan area. Most of the significant progress which has been made to date has been in transporting data across long haul networks like Telenet, which serves a relatively dispersed subscriber base. The local telephone exchange remains a critical bottleneck for local distribution. Many proposed solutions to this local distribution problem which seem attractive at the 100 or even 1000 user level begin to exhibit serious traffic problems at the 10,000 user level and are totally unsupportable at the even higher penetration levels required to make residential videotex a commercially viable business. Other solutions which do have the traffic carrying capacity are inherently expensive and will likely meet with success only in the comparatively less cost sensitive business market. Of the available alternatives, broadband CATV systems offer the best promise for solving this problem. Not only are they ideally suited for the distribution of this class of data traffic, but they offer architectural advantages to the developers of both videotex terminal products and videotex services which cannot be had over narrow band networks at any price. This paper examines a broadband approach to the problem of choosing a "conduit" for videotex and related services, in particular describing the MetroNet interactive cable data network and the Communicom videotex terminal products being developed by General Instrument. A comparison is made to telephone and LADT, AT&T's Local Area Data Transport system, in an effort to bring out the strengths and weaknesses of the various media.

### THE PROBLEM

Much attention in the industry has thus far been focused on both the right service mix required to attract subscribers and the appropriate user terminal features required to support this service mix, particularly in the display area. Comparatively little attention has been paid to determining the optimum network architecture required to connect these terminals to the large host computer systems offering data services. Perhaps this is because substantial network problems are not likely to manifest themselves until after the services achieve significant penetration. Perhaps this is because the network of choice is just naturally assumed to be the ubiquitous twisted pair telephone network, or minor modifications thereof. In any case, prudent planning requires an examination of those obstacles that will have to be overcome after a successful service launch but before widespread commercial exploitation.

To date, nearly all significant videotex work has, by necessity, centered around telephone based delivery. The fundamental weakness of the existing public switched telephone network is, oddly enough, its strength. Over one hundred years has been spent fine tuning the telephone system to optimally support voice calls. These calls have very different aggregate traffic statistics than the data calls expected for videotex. Most notably, the average voice call generated in the residential environment lasts three minutes as compared to the expected fifteen to twenty minutes for videotex calls. Resources within the local telephone central office are provisioned and demand allocated based on these aggregate statistics. Clearly, this is not a problem if videotex penetration remains low. After all, households with talkative teenagers have not destroyed the technical viability of the telephone network (although the probable phasing out of flat rate local calling will forever alter the subsidies that make this phenomenon possible). If videotex penetration becomes significant, however, and some estimates run as low as 3 1/2%, this fine balance created between the supply and demand of specific switching resources in the local central office will be upset, resulting in a greatly diminished grade of

service (i.e., availability). As quoted from a former Bell Labs engineer who was part of the original LADT design team, "it's worse than Mother's Day" (1). It is a very risky strategy to totally rely on a system that strangles on its own success. Clearly, a timely migration strategy is in order.

LADT is AT&T's suggested solution for videotex and services like it, a response to this potential "calamity of success". Viewed in a defensive perspective, LADT can be seen as being as important to protecting the existing telephone system from data as it is to exploiting new market opportunities. But how does LADT stack up for videotex? Its heirarchical, packet switched architecture appears to be sufficiently robust to carry the volume of data expected (2). It is also very well matched to the long holding time/bursty data traffic expected from videotex calls. But what about the costs? An examination of the LADT tariffs (3) filed in Florida yields an interesting insight into the likely future of LADT. This tariff estimates a usage charge of \$14 per month for the typical residential videotex subscriber, a pretty substantial entry fee just to log on. This, of course, rules out services with a utility to the end user of less than \$14 per month, even if the actual service is free. This average figure, moreover, is based on the dial-up version of LADT, which suffers from the same traffic problems under concentrated loads as the existing telephone network. It must be viewed, therefore, as an entry strategy for LADT, which must eventually move subscribers over to the direct connect version (data above voice on the local loop) as penetration exceeds 3% or 4%. While there are additional benefits to the direct connect version, such as lack of contention with the telephone and a 4800 bps data rate vs. 1200 bps, the tariff estimates the typical monthly bill at \$40. One has a difficult time imagining a mature residential videotex service based on a \$40 per month communications bill.

Why, then, is AT&T aggressively pursuing LADT? Interestingly enough, \$40 is a bargain for 4800 bps switched service compared to existing private lines business

data tariffs, which run into the hundreds and even thousands of dollars per month depending on the type of line and the distance. From this, one can reasonably expect that LADT, or something like it, will find a happy and profitable home in the exploding business data market. This is small comfort to the emerging residential videotex industry, however. Hopefully, this sobering realization will lead to the examination of the other major conduit entering the home.

#### CABLE TV

As there is no monolithic "cable industry" to study, but instead a complex conglomeration of hundreds of operators ranging from sophisticated Fortune 500 companies to the remaining "mom and pop" operations, it is difficult to assess cable's potential without focussing on particular markets and systems which are likely to be key to videotex. These, of course, are the major urban and suburban systems generally operated by large MSOs (Multiple System Operators) each supporting upwards of 50,000 subscribers. If one assumes that videotex will be primarily a metropolitan phenomenon driven by a handful of major service providers, then restricting one's attention to these larger candidate systems should not be unduly limiting. This is especially noteworthy given the following broad generalizations about these larger systems:

- a) all of them are two-way capable, that is, sufficient bandwidth has been set aside (usually in the 5 MHz - 30 MHz band) to support the future addition of upstream transmission,
- b) many of them, especially those built in the last three years as well as those that will be built as a result of recently awarded franchises, are going in two-way active, with the basic cost of this capability already absorbed in the construction base,
- c) most of these systems generally have un-utilized or underutilized downstream capacity, currently occupied by things like character generators carrying billboard services, and

- d) almost all of the operators have some obligations to offer two-way interactive services as part of the price of obtaining the franchises.

Examining these very broad factors usually leads to initial excitement for videotex promoters. This is quickly followed by a growing disappointment when the realization sets in that there is no equipment currently available to take advantage of these opportunities on anything but a "concept trial" basis. The fact is, most MSOs are almost exclusively concentrating on their bread and butter business, premium entertainment TV, and are not predisposed to make risky investments in unproven services. Cable equipment vendors as a group are not technology driven, hence their entire focus has been on meeting the immediate demands of their customers by making more channels available to keep up with franchising promises (witness the march from 350 MHz to 450 MHz, 500 MHz, and now 550 MHz) and on defeating "pirates" that are sapping MSOs revenues by stealing premium services (witness the addressability revolution). Progress on the data communications front has been limited, with many false starts and few successes. Attention has also been concentrated on the business and institutional data market, which is perceived as being less cost sensitive, less risky, and less complicated.

So how can all of this lead to a broadband solution for residential videotex? Two things are required. The first is developing a system that "works" (i.e., the traffic arithmetic adds up and the costs per subscriber are low) and the second is convincing a skeptical entertainment oriented customer (i.e., the MSO and his subscribers) to buy it. General Instrument has tackled both these problems with a data network called MetroNet and a combined entertainment video converter and videotex terminal, the first member of the Communicom product line. The essential characteristics of this approach will be described in the remainder of this paper.

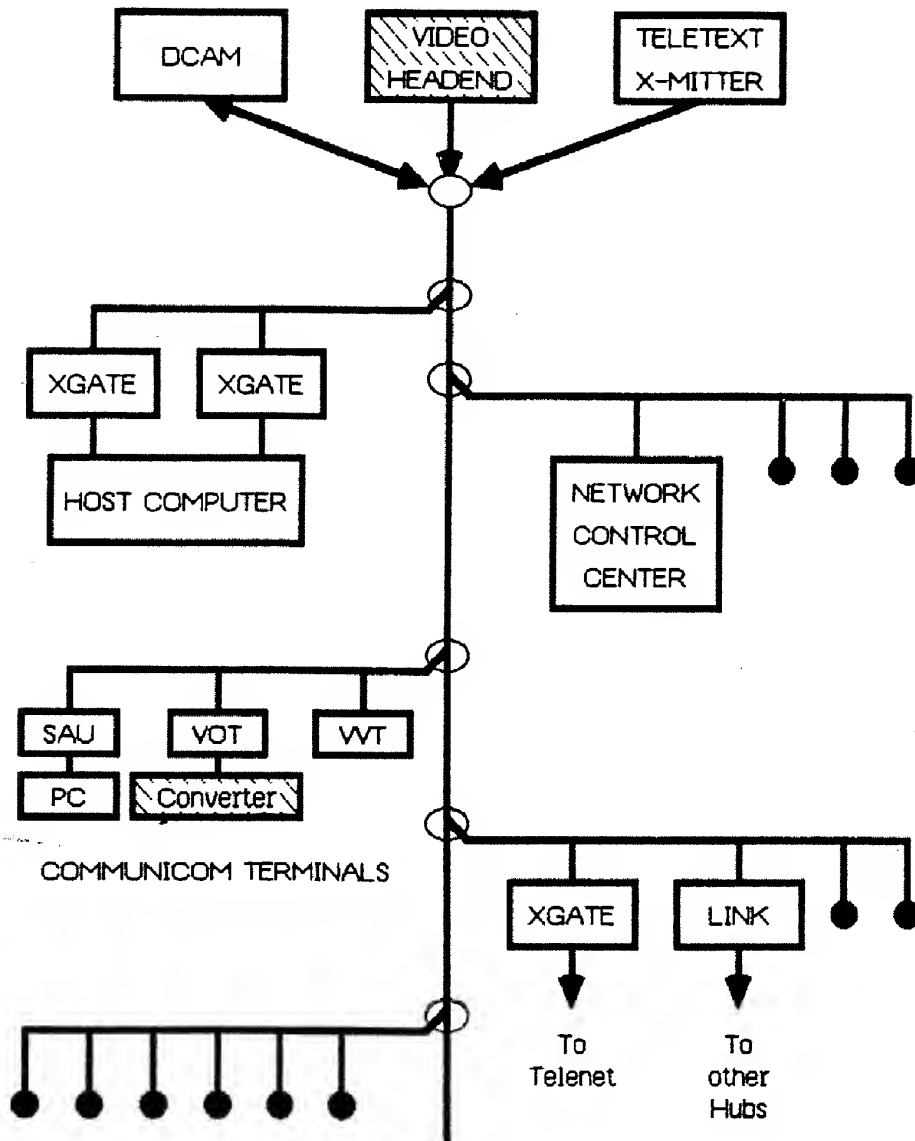
### METRONET

The MetroNet network is a direct offshoot of the LocalNet broadband local area network system developed by Sytek Inc., a General Instrument affiliate. (For a detailed technical description of MetroNet see reference 4.) MetroNet enhances a standard "tree and branch" cable TV system designed for the delivery of broadcast video by transforming a selected portion of the spectrum (as few as one and at most six regular TV channels) into a "global bus" switched data highway. This data highway is used to support both two-way videotex sessions between any two points on the cable and one-way "teletext" channels, which could contain the most frequently accessed frames of information as well as downloaded software. This transformation is accomplished via the installation of some relatively modest equipment in the headend and can be done, most importantly, with no topological changes in the existing cable plant. (As with any cable data system, including the two-way addressable converters currently being deployed to support multi-tiered pay TV, it requires the activation of the upstream amplifiers.)

Figure 1 shows a block diagram of the system. Up to fifty, 300 KHz wide, 128 kbps, two-way channels are created by linking a portion of the upstream bandwidth to a portion of the downstream bandwidth through a digital packet repeater in the headend. This repeater, called a DCAM (Data Channel Access Monitor) is responsible for performing noise clean up on the received packets (a simple demod-remod), checking their headers to see whether they are properly authorized to be on the system (a simple table look up), and rebroadcasting them on an associated downstream channel. Each of these fifty channels can be shared by up to 300 simultaneously active users utilizing a highly efficient channel contention scheme (CSMA/CD) which is commonly used in most local area network products. Any terminal can be directed to tune its modem to any one of these fifty data channels, thus making every host computer system on the network directly accessible.

The "teletext" transmitter in the headend creates an additional fifty 300 KHz wide, 128 kbps, one-way teletext channels which can also be received by any terminal via



FIGURE 1 : *METRONET ARCHITECTURE*

proper tuning of its modem. (This is not to be confused with either Vertical Blanking Interval teletext or full-field teletext which modulates data onto the video carrier.) The teletext transmitters can be uploaded at various times during the day over the two-way channels from any authorized service provider's host computer on the network. This gives the service provider the capability to offload the most frequently accessed frames onto the teletext system, which is inherently load independent. An application running in each terminal will decide whether a requested frame is available via a teletext channel or can only be obtained via a two-way videotex session, blending the information received from these two sources in a manner that is transparent to the user. This will not only reduce the total traffic load on the system but will have significant ramifications on the economics of service providers, who clearly need a way to dramatically reduce their capital investment in large host computer systems. The teletext transmitters also have the important job of distributing the basic terminal operating software, which is downloaded into each videotex terminal whenever power is applied (more on this later).

The DCAM and the teletext transmitter take care of the fundamental data distribution chores of the network. It is important to note that these are not packet switches and, hence, require no sophisticated protocol intelligence nor expensive processing power, as do the switching nodes in LADT. They can also be deployed modularly on a per channel basis, reducing the initial capital costs required to get a system started with relatively few subscribers.

Managing these data channels, establishing sessions between users and service providers, and collecting transport billing statistics is the job of the Network Control Center. This can be attached anywhere on the network and does not need to be co-located with the headend. The network control center is also not involved in ongoing packet switching, and therefore can be implemented on a relatively inexpensive mini or even microcomputer hardware base.

Service providers' host computers, both large and small, can attach to the network at any point on the system, again with no requirement to be co-located or trunked into the headend. They do this through an X.25 interface called an XGATE, which supports a standard X.25 protocol at speeds up to 56 kbps. Translation into the internal MetroNet protocols is accomplished within the XGATE and is transparent to the service provider. Public data networks such as Telenet and Tymenet can attach to MetroNet via these XGATES as well, providing access to remote services such as The Source and Compuserve.

Multiple cable hubs and even multiple adjacent cable systems under common administrative control (for data) can be interconnected via inter-hub links. These can not only be used to increase the capacity of a single cable system by dividing it down into multiple sub-networks but can extend the geographic coverage of a MetroNet beyond the bounds of a single cable franchise.

With the configuration described above, utilizing the same traffic model as that used in the LADT tariff, a single MetroNet hub can be shown to support upwards of 100,000 videotex subscribers, with multiple hubs supporting even more. Since most cable hubs usually serve no more than 50,000 total subscribers, enough headroom remains in the traffic model for the services to be tremendously successful without choking on the resulting traffic. This can be done, moreover, at an estimated cost of less than one tenth of the capital installed cost per subscriber as LADT.

Remaining to be described are the most common elements on the network, namely the subscriber terminals. As will be seen in the next section, these terminals can draw on the unique architectural strengths of MetroNet, as well as the availability of entertainment video, to create an integrated system of unparalleled performance and flexibility.

COMMUNICOM

The planned Communicom terminal family, all based on a common architecture and implementation, has three members. These are:

- SAU - Subscriber Access Unit. The SAU is an intelligent, frequency agile, 128 kbps modem. It allows the connection of a customer owned terminal or PC to MetroNet via a standard RS-232 or backplane connection, depending on the configuration.
- VOT - Videotex Only Terminal. The VOT is an intelligent, interactive graphics terminal containing an integral SAU which supports NAPLPS (5) videotex services, single and multi-user animated video games, and down-loaded software. It can be used in conjunction with any standard CATV converter or used alone. In either case the home TV, as usual, is used as the display device.
- VVT - Video Videotex Terminal. The VVT integrates a VOT with an addressable CATV converter. This will support not only videotex services and standard video entertainment services (e.g., HBO) but novel combinations of video and videotex such as video home shopping.

The members of this terminal family share a unique architectural characteristic in that the entire terminal operating system, communication software package, display protocol package (NAPLPS or any other display standard), and user interface software are all downloaded over the cable into RAM each time the terminal is turned on. One or more of the fifty MetroNet teletext channels are dedicated to distributing this software, which allows the download to be accomplished in a load independent manner (i.e., no incremental network traffic is generated even if 20,000 subscribers turn on their terminals simultaneously). The speed of these channels (128 kbps) also means that the user will only have to wait a matter of seconds for the download to complete.

This totally software based architecture is critical for two reasons. The first is that it allows the terminal software to be improved and corrected even after the product is delivered and in use. With MetroNet, the system operator can update the software in hundreds of thousands of terminals merely by uploading a new version into the teletext headend. The second key ability is that individual software modules can be paged off of the teletext channels on demand, supporting a wide variety of terminal software configurations tailored to each application. In a sense, the teletext channels are being used as free read only disks. This will allow, for example, the bulky NAPLPS software package to be replaced with a streamlined animation driver when the user switches from frame retrieval videotex to action video games, or the overlay of a BASIC interpreter if the user wishes to do home computing.

The remaining characteristics of these terminal products fall well within the mainstream of the videotex terminal and low cost home computer industries, which are quickly becoming commodity businesses. The strength and uniqueness of the products are clearly drawn from MetroNet.

#### CONCLUSION

Hopefully, this brief description of MetroNet and Communicom has shown that an extremely powerful and economical system solution of the metropolitan distribution problem can be achieved. With a broadband approach such as this, the traffic arithmetic adds up\* and the major component of the overall cost per

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\* Details are left as an exercise to the reader. Assume 50 two-way channels at 128 kbps with a CSMA/CD protocol that permits 70% channel utilization. Allow 15% for protocol overhead and use your own numbers for average throughput per terminal and peak port occupancy. Don't forget the effect of the offloading onto the teletext channels.

subscriber is placed in the home terminal, where it belongs, and not in the network, which after all is nothing but a "conduit" as far as the subscriber is concerned. Manufacturing this terminal at a price low enough to achieve widespread penetration remains a challenge that depends primarily on the volumes achieved as well as the manufacturers' experience in cost reduced off-shore manufacturing. Time is on our side on this one, if the key pioneer service providers can hold out, as the ongoing decline in the cost of the critical electronic components shows no sign of letting up. Low cost manufacture has also been a major driving force in the cable industry for some time now (there is no need to get used to competition as if it were a new phenomenon) so prospects look good for a cable approach to videotex if the product can be sold to an entertainment oriented cable MSO. This is where the combined video videotex terminal comes in, which allows videotex to be marketed to individual subscribers as just another premium tier of cable services. This avoids forcing an all or nothing purchase decision on an uneducated consumer for an unproven medium in the face of direct competition from heavily promoted home computers. The enhanced animation and video game capability of Communicom, especially the ability to play multi-user interactive games with other subscribers on the network, should also appeal to an entertainment oriented market. (Even videotex purists have to admit that games are the most popular service on any system, even when the games are awful as they almost universally are on frame retrieval videotex systems.)

Time, arithmetic, and economics will solve the dilemma of delivery. The one thing that is safe to predict is that sooner or later videotex is going to happen. When it does, the choice of conduit will be limited, as only cable operators and the local telcos have the historical and political prerogative of wiring up homes. Each has their own entrenched turf to exploit (video distribution and local telephony) and each is eyeing the remaining open field (data). Because they both have an enormous investment in existing plant, the battle will by necessity be between a switched, twisted pair approach and a multiple access, coaxial cable approach. (Fiber optics, attractive as it is for high density trunking, is still a long way off as an economically viable medium for local distribution.)

Architecturally, cable has the edge for carrying the class of data traffic likely to be produced by videotex users. Its biggest drawback is its geographic distribution. Even in the big metropolitan areas, cable isn't everywhere. The fringe neighborhoods and rural communities will have to be left to the local telephone company, who are the only ones in a position to offer universal service. This will leave videotex service providers in the interesting position of having to play a straddle between cable and telephone in order to optimally cover a region. This should make for some fascinating business dynamics.

#### REFERENCES

1. "Firm plans to link videotex service to cable TV lines", interview with R. McNamara, Infoworld, Volume 5 #28, July 1983, P. 17
2. David B Loring, "Videotex Highways: The Telephone Approach", Proceedings of Videotex 83, Online Inc.
3. Local Area Data Transport (LADT) Service, General Subscriber Service Tariff, Southern Bell Telephone Company, April 15, 1983
4. Mete M. Gur, "An Analysis of the Networking Requirements for a Residential Two-Way CATV System: MetroNet", Sytek Inc., IEEE-Globecom - 83, November 28, 1983
5. "North American Videotex/Teletext Presentation Level Protocol Syntax (NAPLPS)", ANSI X 3.110/CSA T5000-1983.